

DEVELOPMENT AND APPLICATION OF HYPERSENSITIVE INFRARED SOUNDER OZONE RETRIEVAL PRODUCTS FOR OPERATIONAL METEOROLOGY

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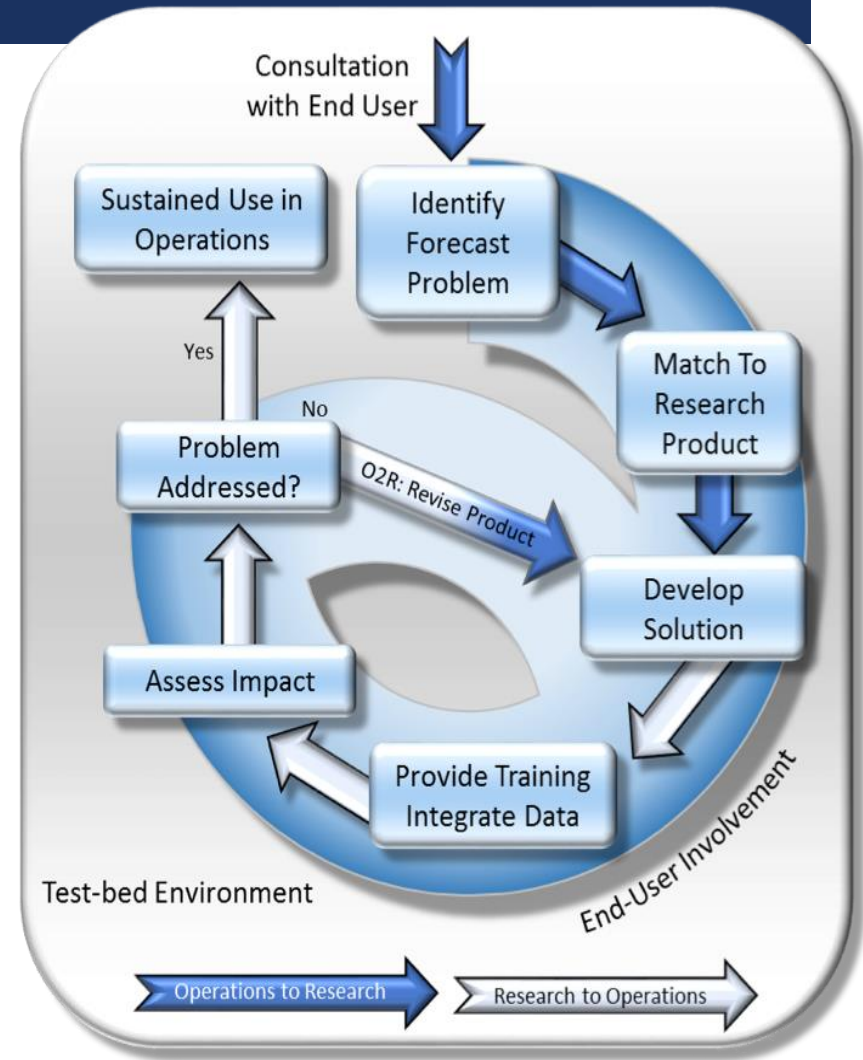
SHORT-TERM PREDICTION RESEARCH AND TRANSITION CENTER
NASA MARSHALL SPACE FLIGHT CENTER

NASA SOUNDER SCIENCE TEAM MEETING

15 SEPTEMBER 2016

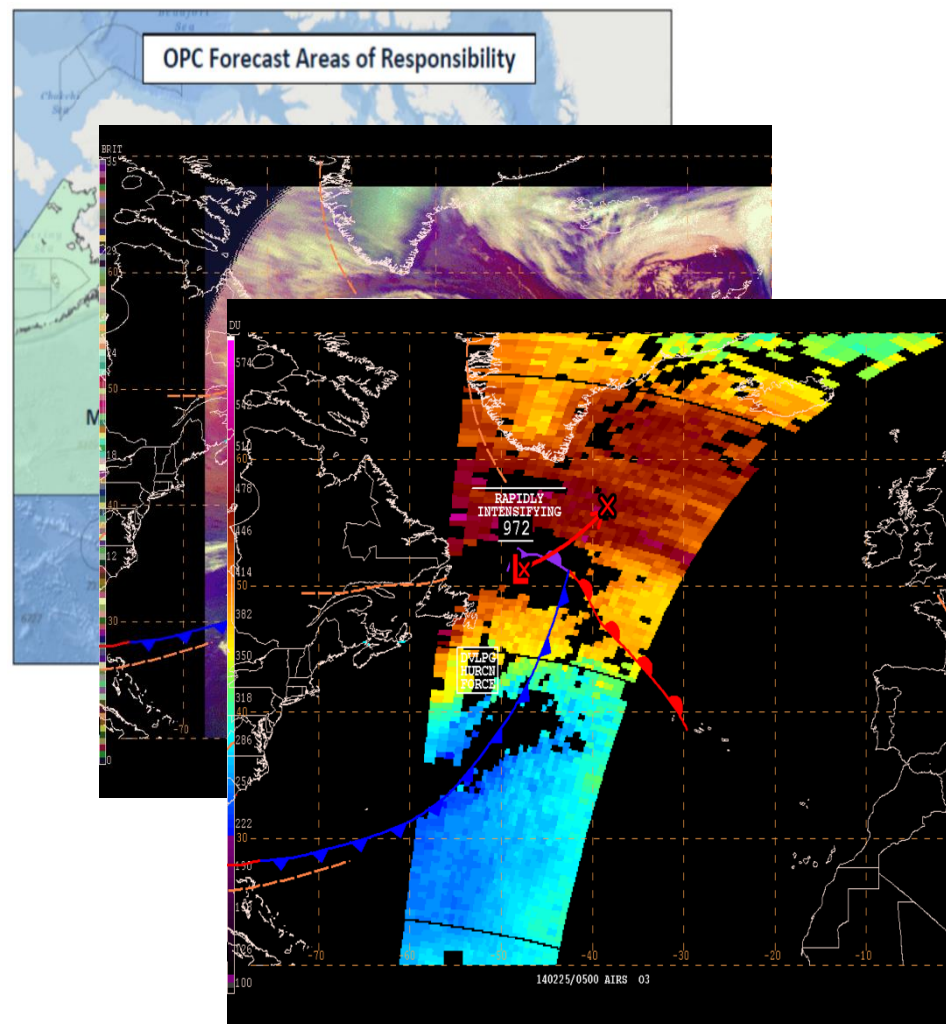
SPORT MISSION AND PARADIGM

- ***Apply satellite measurement systems and unique Earth science research to improve the accuracy of short-term weather prediction at the regional and local scale***
- Bridge the “Valley of Death”
- Can’t just “throw data over the fence”
 - Maintain interactive partnerships with help of specific advocates or “satellite champions”
 - Integrate into user decision support tools
 - Create forecaster training on product utility
 - Perform targeted product assessments with close collaborating partners
- Concept has been used to successfully transition a variety of satellite datasets to operational users for nearly 10 years



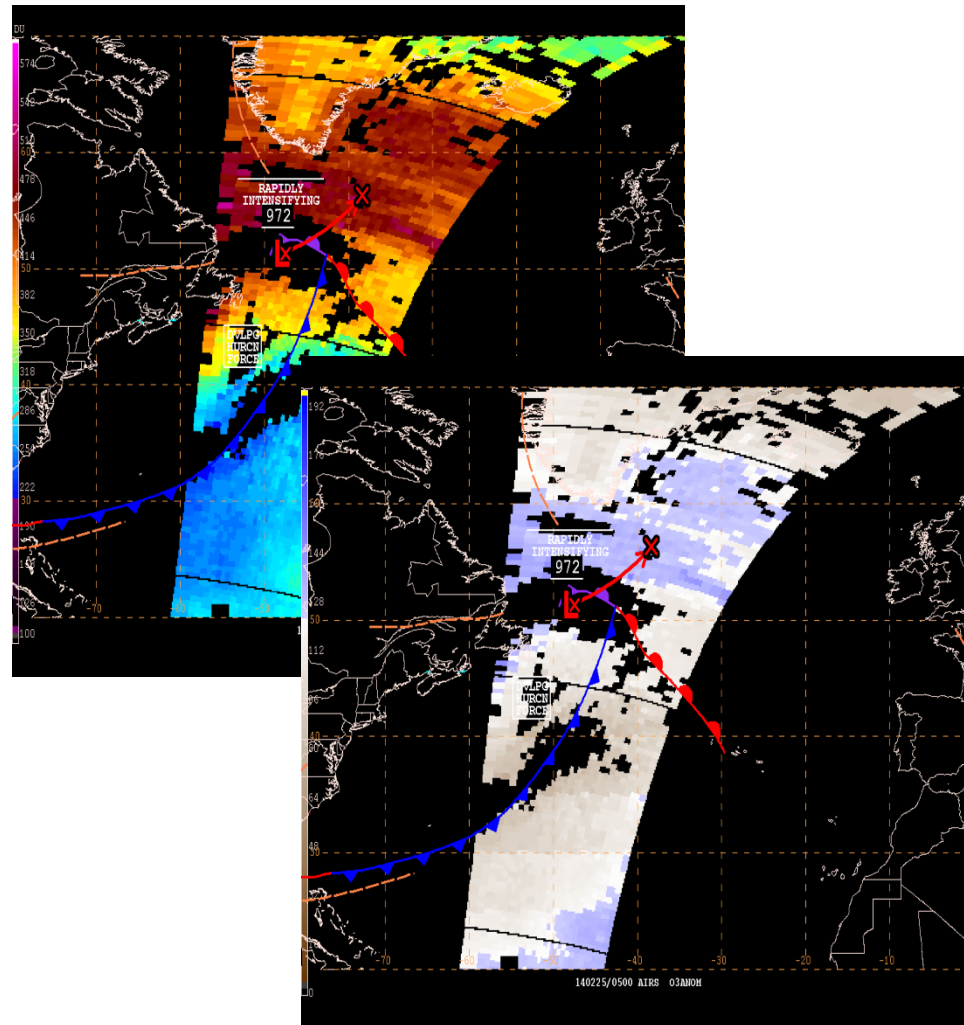
OPERATIONAL FORECAST CHALLENGE

- NOAA NWS Ocean Prediction Center forecasts hazards associated with intense storms that develop in the Pacific and Atlantic Oceans
 - High winds
 - High wave heights
- The Air Mass RGB was introduced by SPoRT via the GOES-R Proving Ground in 2011-2012 to aid monitoring intense storms
- The Air Mass RGB combines multiple satellite bands to enhance regions of warm, dry, ozone-rich stratospheric air
- SPoRT explored the use of NASA AIRS ozone retrievals as a stratospheric air tracer and tropopause folding which can enhance storm development



FORECASTER INTERACTION

- In 2011-2012 AIRS Version 5 Level 2 ozone retrievals were put in N-AWIPS format for National Centers
- AIRS Ozone product was used experimentally in operations
- Forecasters expressed concern whether the high ozone values we representing stratospheric air or just naturally elevated but within the climatological range
- Globally, average total column ozone is 300 Dobson Units (DU) but varies from about 230 – 500 DU
- SPoRT developed an Ozone Anomaly product for easier identification of stratospheric air

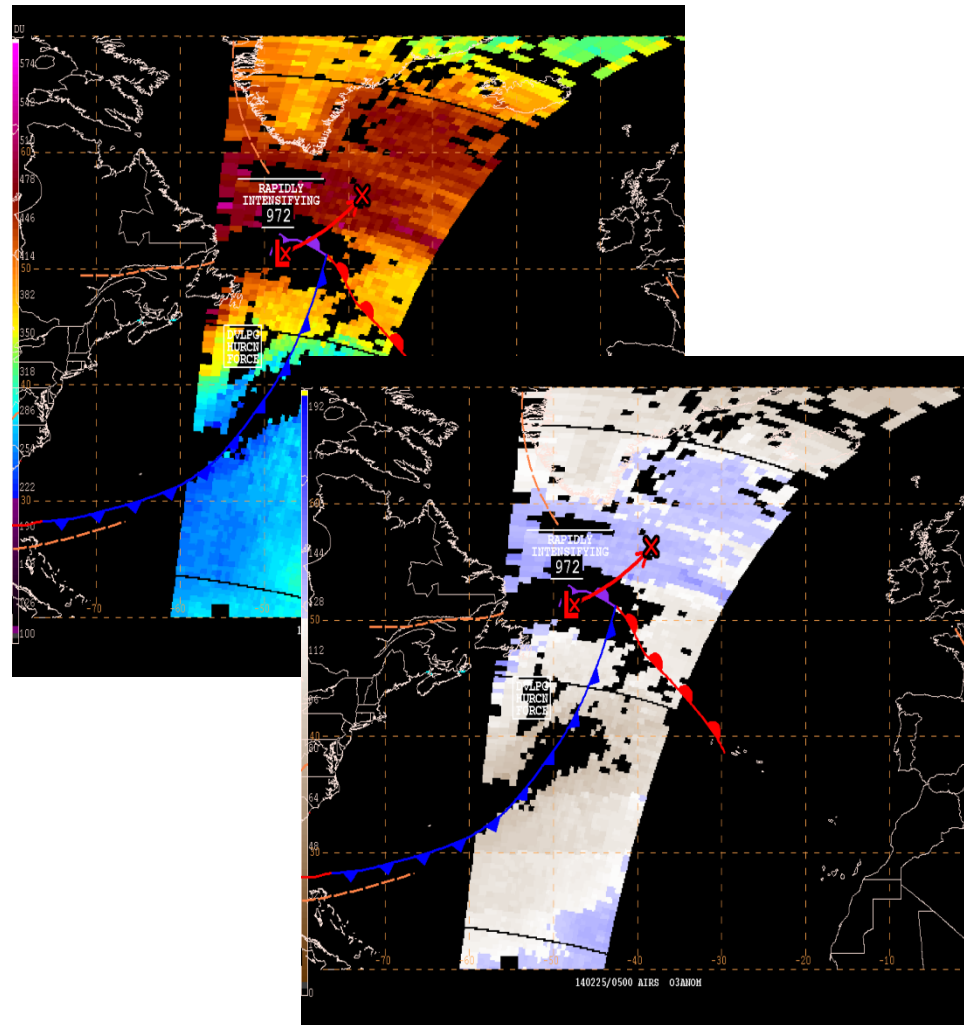


OZONE ANOMALY PRODUCT

- Total Column Ozone is compared to a stratospheric ozone climatology to identify regions of anomalous total column ozone where elevated values are consistent with mean stratospheric ozone values
- A global and zonal mean monthly mean climatology of stratospheric ozone derived from the NASA Microwave Limb Sounder by Ziemke et al. (2011) is used to calculate the percent of normal

$$PON = \frac{TCO}{climo} \times 100$$

- Stratospheric air has ozone values at least 25% larger than the climatological mean (Van Haver et al. 1996)
- Product ranges from 0-200 % and regions $\geq 125\%$ of the climatological mean are blue



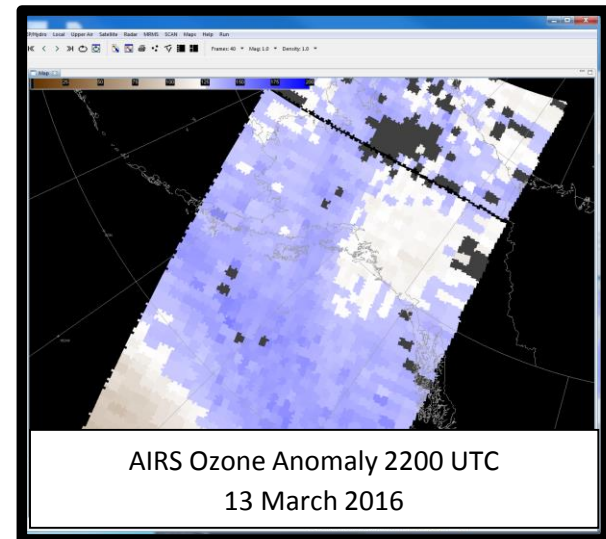
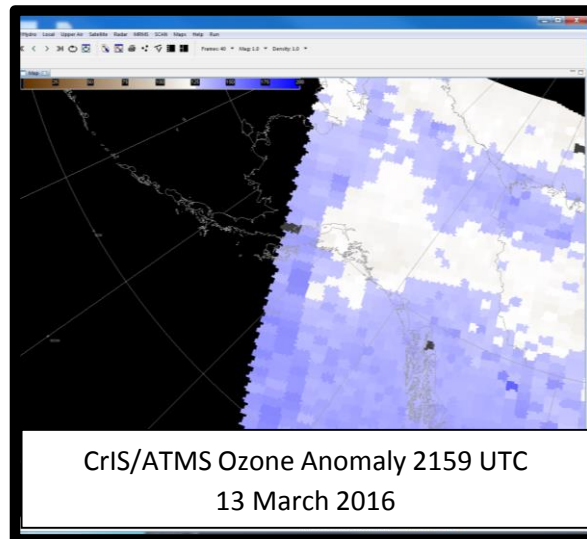
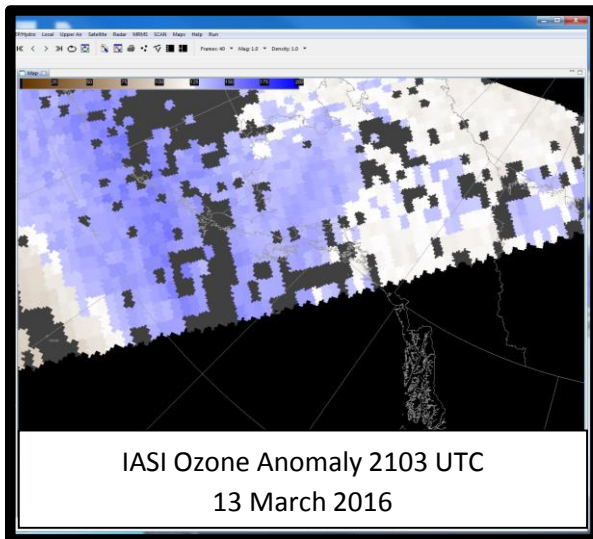
FORECASTER INTERACTION

- During 2013-2014 winter AIRS ozone products were evaluated by NOAA NWS National Centers
 - “**Reinforce the evidence from RGB** of the descent of stratospheric air with tropopause folding.”
 - “This has allowed me to **have confidence in assessing the RGB Airmass product** and also in conjunction with gridded GFS output that a perceived PV anomaly is real or not.”
- Forecaster feedback led to new product development

“There may have been 1 occasion where 1 pass did line up over the US with the spot I was interested in. In that case, it was helpful in reaffirming my suspicions on whether stratospheric air was present. Otherwise, the passes were few and far between and not particularly timely. If there was greater coverage of passes and not as much of a lag, it would certainly be useful.”

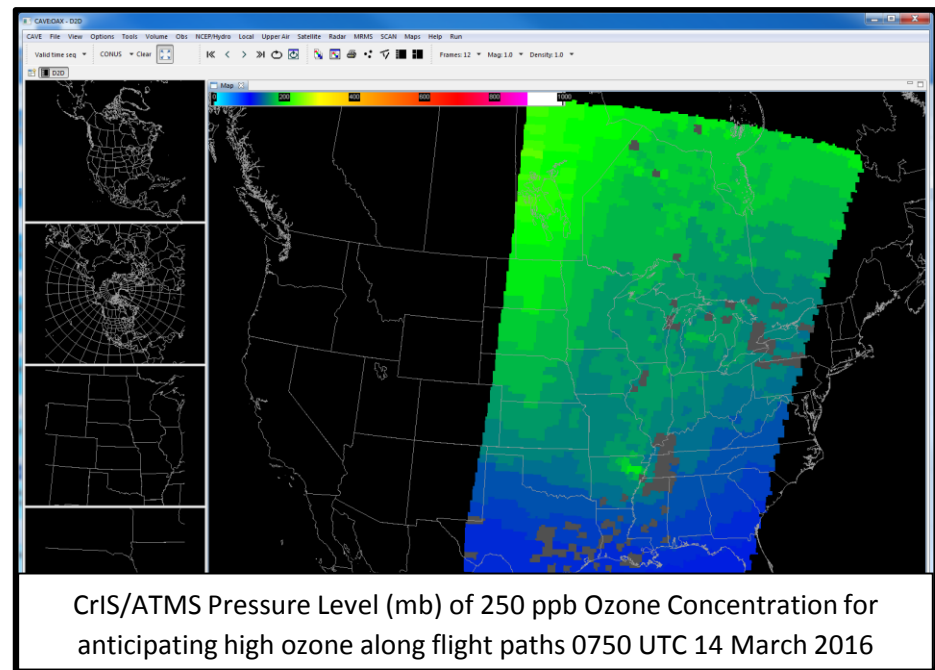
NEW PRODUCT DEVELOPMENT

- Expanded ozone product to additional sensors
- Total column ozone and ozone anomaly available from AIRS, CrIS/ATMS, and IASI
- Additional overpasses for forecasters to evaluate
- Products now available in NAWIPS *and* AWIPS-II



ADDITIONAL APPLICATIONS

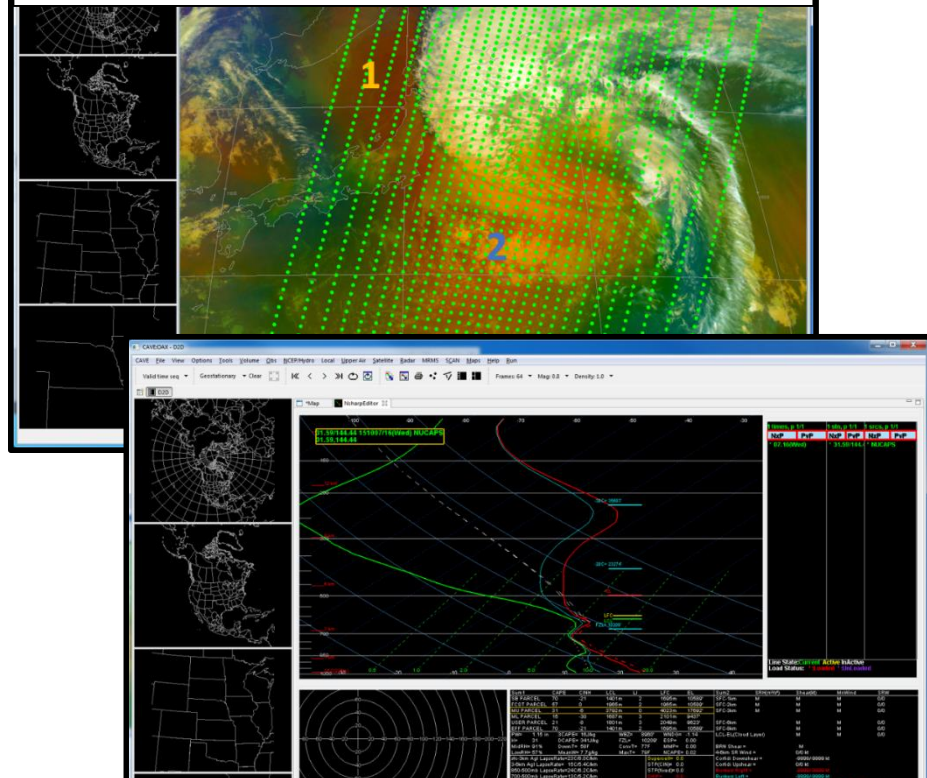
- Aviation Weather Center
 - Compare ozone products to Air Mass RGB to anticipate turbulence near the jet stream
 - Monitor high ozone along flight path that could pose passenger and crew health concern
 - Height of 250 ppb Ozone product in AWIPS-II for the National Aviation Meteorologists
- National Hurricane Center
 - Compare ozone products to Air Mass RGB to anticipate hurricane tropical to extratropical transition
 - Use NUCAPS CrIS/ATMS profile to analyze vertical depth of thermodynamic variables and identify stratospheric air influence



EXTRATROPICAL TRANSITION

- JPSS funded project to investigate use of NUCAPS soundings for hurricane tropical to extratropical transition
- Since NUCAPS soundings are already in AWIPS-II this projects investigates the utility of NUCAPS soundings for another unique forecasting challenge
- NUCAPS soundings can compliment the Air Mass RGB by providing insight about the vertical structure of the atmosphere

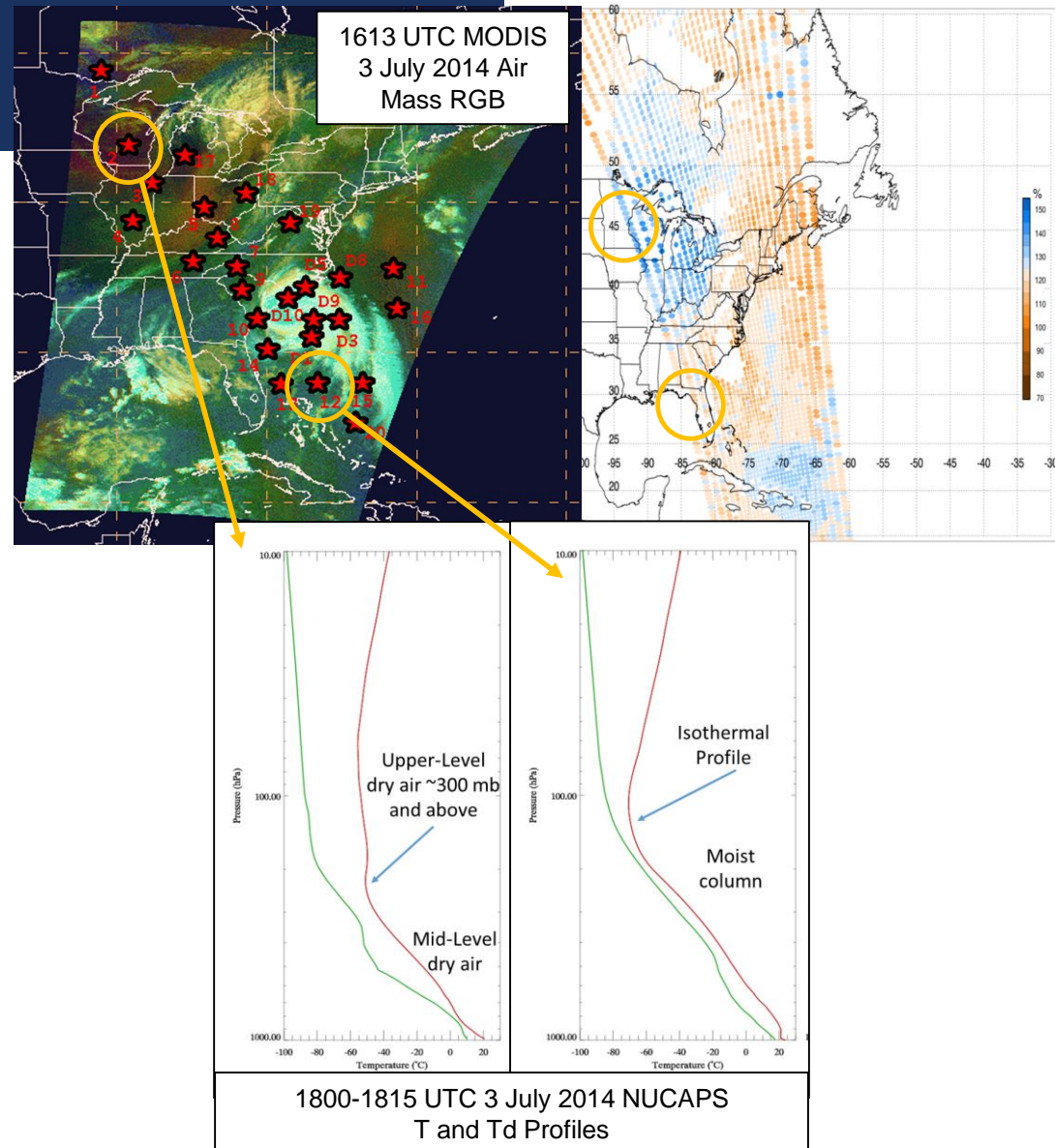
Severe Tropical Storm Choi-wan Himawari-8 AHI 7 October 2015 1520 UTC Advanced Baseline Imager Air Mass RGB and NUCAPS Sounding point locations



NUCAPS Sounding point locations 7 October 2015 1500 UTC taken near point 2 in a region of upper-level dry air (orange coloring) and mid-level clouds (light orange coloring)

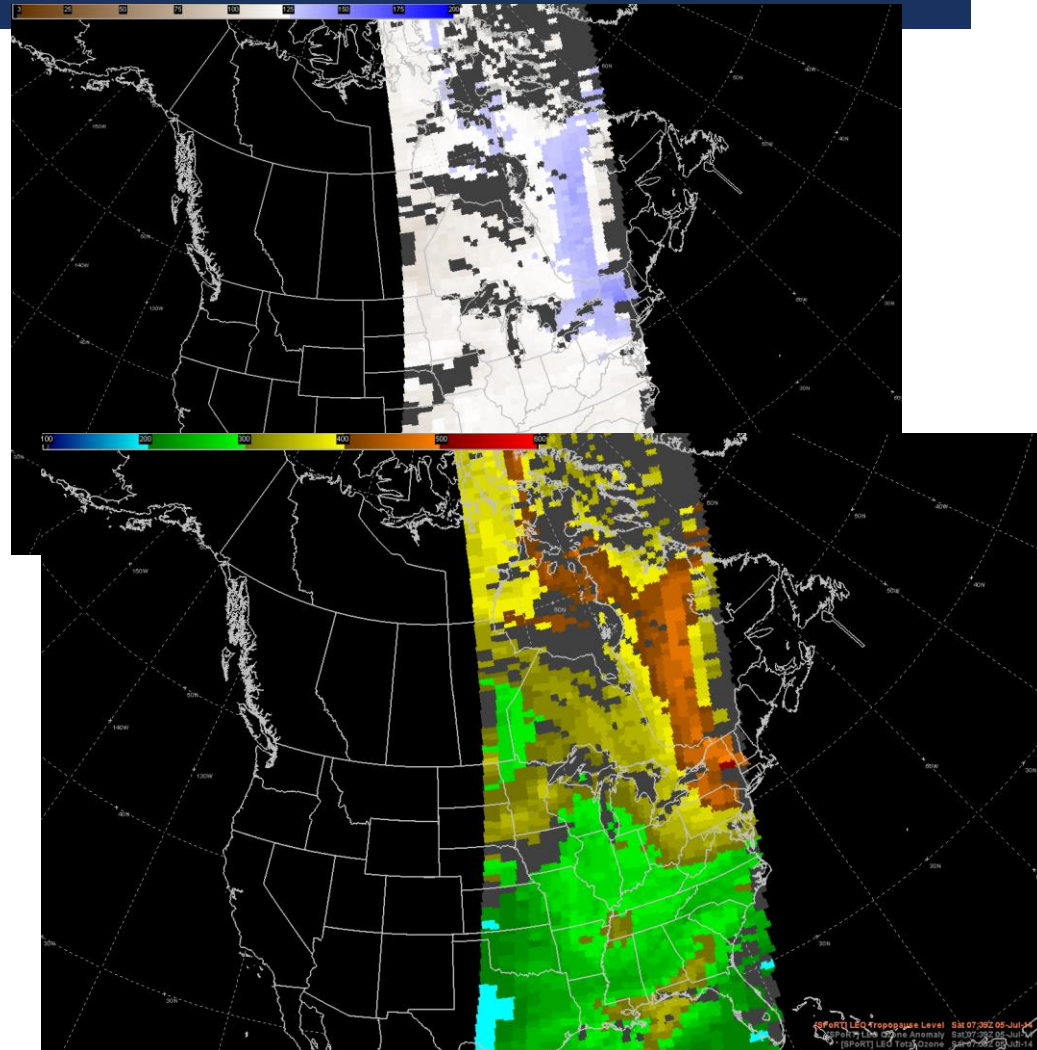
EXTRATROPICAL TRANSITION

- Investigated Sandy 2012, Arthur 2014, and Atsani 2015
- Profiles in red/orange regions confirm mid- and upper-level dry air and lower tropopause
- Profile near the storm in blue/green regions confirm a moist column and a higher tropopause



TROPOPAUSE LEVEL PRODUCT

- Thouret et al. 2006 defined a climatological ozone concentration at the dynamic tropopause
 - Tropopause: a transition zone 30 mb thick centered on the 2 PVU surface
 - Tropopause ozone concentrations approximated by a sine seasonal variation
 - maximum in May (120 ppb)
 - minimum in November (65 ppb)
 - $91 + 28 \sin(\pi * (\text{month} - 2) / 6)$
- Short-applications based training developed
- Ongoing product demonstration with National Centers to assess product utility in operations



SUMMARY

- SPoRT is a proven community leader for transitioning satellite products to operational end users and is working to bring data from hyperspectral infrared sounders to forecasters
- SPoRT has worked closely the GOES-R and JPSS Proving Ground to develop and transition ozone products to National Centers for forecasting rapid cyclogenesis and hurricane force wind events
- Products are derived from AIRS, IASI, and CrIS/ATMS retrievals and are available in NAWIPS and AWIPS-II
- SPoRT is continuing to investigate the utility of NUCAPS profiles for other applications for aviation forecasting and hurricane tropical to extratropical transition

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